Actuary: Hurricane Relief

Performance Task

Introduction

Actuaries analyze data and make models in order to predict the probability of the financial impact of uncertain events. Using their broad knowledge of statistics, finance, and business, actuaries help to collect and analyze data to estimate the probability and likely cost of an event such as the aftermath of a hurricane.

In this task, you will take on the role of an actuary who will be helping a non-profit organization to prepare for upcoming hurricane relief related costs. In the aftermath of hurricanes, nonprofit organizations such as the Red Cross, have sheltered thousands of people, sent out emergency response vehicles into neighborhoods to deliver meals, snacks and relief items, and had volunteers provide emotional and spiritual support in addition to health services. In order to perform these functions, the organization is dependent on donations from businesses and individuals.

Big Idea / Essential Questions

Big Idea

- Data can be modeled and used to make inferences.
- Patterns exhibit relationships that can be extended, described, and generalized.
- The Earth is a complex and dynamic set of interconnected systems (e.g. geosphere, hydrosphere, atmosphere, biosphere) that interact over a wide range of temporal and spatial scales.
- Effective research requires multiple sources of information to gain or expand knowledge.

Essential Questions

- How can data be organized and represented to provide insight into the relationship between quantities?
- How can probability and data analysis be used to make predictions?
- How and why is the Earth constantly changing?

G.R.A.S.P.

Goal

As an actuary, you are helping a nonprofit organization to lobby for and collect donations. As part of your work, you will inform the organization about the potential probability of hurricanes and their severity so they are aware of how much money they will need to have on hand.

Role

You are an actuary who is helping a nonprofit organization to predict how much money to raise in order to be prepared for the costs of the upcoming hurricane season.

Audience

Your audience is the nonprofit organization as well as people in communities who are at risk of hurricanes.

Situation

In this task, you will take on the role of an actuary who will be helping a non-profit organization to prepare for upcoming hurricane relief related costs. In the aftermath of hurricanes, nonprofit organizations such as the Red Cross have sheltered thousands of people, sent out emergency response vehicles into neighborhoods to deliver meals, snacks and relief items, and had volunteers provide emotional and spiritual support in addition to health services. In order to perform these functions, the organization is dependent on donations from businesses and individuals. You will also be helping people in hurricane-prone communities by providing them with materials to help them prepare for this risk.

Products

1. Hurricane Scale Placard

Hurricanes are categorized based on their wind speed. Many people are unaware of this fact and think that the higher the category, the more rain they will receive.

One of the education materials you are to create is a placard which will contain information of the hurricane categories. Choose a graphic to show category and wind speed that all people can easily understand (for example, a number line diagram). Express each hurricane category as an algebraic inequality of the wind speed. Also Include a chart that shows the category and typical damage at that scale. This placard will be posted in the offices of the non-profit organization around the US and on its website.

- How are hurricanes categorized?
- What is the typical types of damage for each category of hurricane?
- What type of graphic would easily show increased intensities of wind and hurricane categories?

Hurricane Scale Placard

Achievement Levels	1	2	3	4
	The placard provides few	The placard provides some	The placard provides many accurate facts and details	The placard provides a large

Achievement Levels	1	2	3	4
Research and Information (x1)	accurate facts and details serving the audience with limited information related to the topic and big idea.	accurate facts and details serving the audience with pieces of information related to the topic and big idea.	serving the audience with important information related to the topic and big idea.	number of accurate facts and explicit details providing the audience with critical information related to the topic and big idea.
Organization (x1)	The product is somewhat neat but unorganized. The reader has a hard time following and understanding the important information.	The product is somewhat neat and organized. The reader can partially follow and understand the important information.	The product is mostly neat and organized. The reader can follow and understand the important information.	The product is neat and organized. It is easy for the reader to follow and understand the important information.
Graphic Content (x1)	Graphic is created in a way that minimally supports the visualization of hurricane category and wind speed.	Graphic is created in a way that somewhat supports the visualization of hurricane category and wind speed.	Graphic is created in a way that adequately supports the visualization of hurricane category and wind speed.	Graphic is created in a way that strongly supports the visualization of hurricane category and wind speed.
Algebraic Inequalities (x1)	Algebraic inequalities are correctly shown for few of the hurricane categories.	Algebraic inequalities are correctly shown for some of the hurricane categories.	Algebraic inequalities are correctly shown for most of the hurricane categories.	Algebraic inequalities are correctly shown for each category of hurricane.

2. Hurricane Probability Chart

The non-profit organization would like to know the probabilities of a hurricane hitting the different areas where they work, so they know where to focus their funds.

A worksheet of the NOAA maps with the return periods is attached.

Hurricane Probability Chart Worksheet

You are to select one city from each of the below areas and find the probability of a hurricane returning within the next 5 years, 10 years and 25 years. Using the 2nd map, also determine the probability of receiving a major hurricane (a Category 3 or above) for the same cities.

Choose one city for each area: North of New Jersey; Southern VA to northern NJ; Carolinas and GA; FL (east or west coast); TX or LA.

Develop a chart showing the city names and the hurricane probabilities you determined. Add a short summary which explains your calculations and probabilities and makes a suggestion of the best places for the non-profit to focus their funds within the next 2 Â½ decades.

- What cities have the best chance of getting hurricanes?
- How can probability be used to predict hurricanes?

Hurricane Probability

Achievement Levels	1	2	3	4
Organization (x1)	The chart is somewhat neat but unorganized. The reader has a hard time following and understanding the important information.	The chart is somewhat neat and organized. The reader can partially follow and understand the important information.	The chart is mostly neat and organized. The reader can follow and understand the important information.	The chart is neat and organized. It is easy for the reader to follow and understand the important information.
Use of Maps (x1)	Product shows an inaccurate use of maps when determining cities and hurricane return periods.	Product shows a fair use of maps when determining cities and hurricane return periods.	Product shows a satisfactory use of maps when determining cities and hurricane return periods.	Product shows excellent use of maps when determining cities and hurricane return periods.

Achievement Levels	1	2	3	4
Chart Content (x1)	Few sections of the chart are correct and complete with appropriate labels and units.	Some sections of the chart are correct and complete with appropriate labels and units.	Most sections of the chart are correct and complete with appropriate labels and units.	All sections of the chart are correct and complete with appropriate labels and units.
Probabilities (x1)	Few probabilities are accurately calculated and expressed as a number between 0 and 1.	Some probabilities are accurately calculated and expressed as a number between 0 and 1.	Most probabilities are accurately calculated and expressed as a number between 0 and 1.	All probabilities are accurately calculated and expressed as a number between 0 and 1.
Math Explanation (x1)	Product includes an incomplete explanation of the data displayed in the chart.	Product includes a partial explanation of the data displayed in the chart.	Product includes an adequate explanation of the data displayed in the chart and a recommendation that is based on the data.	Product include a thorough explanation of the data displayed in the chart and a recommendation which is accurate and easy to understand.
Data Analysis (x1)	Product contains an inadequate understanding of analyzing and interpreting data on natural hazards to forecast future catastrophic events.	Product contains a partial understanding of analyzing and interpreting data on natural hazards to forecast future catastrophic events.	Product contains a moderate understanding of analyzing and interpreting data on natural hazards to forecast future catastrophic events.	Product contains a thorough understanding of analyzing and interpreting data on natural hazards to forecast future catastrophic events.

3. Hurricane Cost Chart

The non-profit wants you to research past hurricanes to help determine how much they may cost, and therefore how much money the non-profit needs to raise. Research 10 hurricanes within the last 50 years that affected the US. Record the name of the hurricane, the Category and the amount of the total damages in a chart. Make a prediction on the cost of hurricanes based on measures of center and variability of your data collected. The non-profit would also like a short written summary of your analysis. Be sure to include the following:

- What inferences can you make from the hurricane data you collected?
- Are there patterns in the Category and amount of damage?
- What statistical measures did you use to make your prediction?

- How do measures of center (mean, median, mode) help you analyze data?
- How do measures of variability (range, mean absolute deviation) help you summarize data?

Hurricane Cost Chart

Achievement Levels	1	2	3	4
Population Sample (x1)	The product minimally uses data and statistics from a sample to draw conclusions about a population.	The product partially uses data and statistics from a sample to draw conclusions about a population.	The product adequately uses data and statistics from a sample to draw conclusions about a population.	The product expertly uses data and statistics from a sample to draw conclusions about a population.
Data Analysis (x1)	Product contains an inadequate understanding of analyzing and interpreting data on natural hazards to forecast future catastrophic events.	Product contains a partial understanding of analyzing and interpreting data on natural hazards to forecast future catastrophic events.	Product contains a moderate understanding of analyzing and interpreting data on natural hazards to forecast future catastrophic events.	Product contains a thorough understanding of analyzing and interpreting data on natural hazards to forecast future catastrophic events.
Research	Product demonstrates a lack	Product demonstrates that	Product demonstrates that research was conducted	Product demonstrates that thorough research was

Achievement Levels	1	2	3	4
(x1)	of research conducted around the topic.	some research was conducted around the topic.	around the topic using few credible or appropriate sources.	conducted around the topic using several credible and appropriate sources.
Chart Organization (x1)	The data collected is unorganized and lacks appropriate units or labels.	The data collected is somewhat organized in a table or chart containing appropriate units or labels.	The data collected is organized in a table or chart containing appropriate units and labels.	The data collected is organized in a neat, easy to read table or chart containing appropriate units and labels
Written Summary (x1)	Student does not use research or statistical analysis. when attempting to justify their conclusions.	Student minimally justifies their conclusions based on research findings and statistical analysis.	Student sufficiently justifies their conclusions based on research findings and statistical analysis.	Student thoroughly justifies their conclusions based on research findings and statistical analysis.
Statistical Measures (x1)	The product shows a limited use of measures of center and variability to make a prediction based on data collected.	The product shows a partially correct use of measures of center and variability to make a prediction based on data collected.	The product shows a satisfactory use of measures of center and variability to make a prediction based on data collected.	The product shows a thorough and correct use of measures of center and variability to make a prediction based on data collected.

4. Visual Model

Your task is to create a diagram that provides important information related to the sources and formation of tropical cyclones that can become hurricanes impacting the United States. Your diagram should visually explain how these disturbances can move and develop around the globe based on the environmental conditions present. Finally, indicate through this visual, how all the necessary factors help determine where the hurricane may make landfall in the United States.

Within your diagram be sure to address:

- Times of year
- Latitudinal patterns
- Water temperature
- Wind speed and directions at different altitudes that help form the hurricane
- Air composition
- Coriolis effect and landforms
- Atmospheric patterns including converging and diverging winds

- How do hurricanes form?
- How do Earth systems impact the movement of tropical cyclones and hurricanes around the world?
- How does the Sun and latitude impact hurricane formation?
- How can monitoring Earth systems impact hurricane preparedness in the United States?

Visual Model

Achievement Levels	1	2	3	4
Movement of Atmospheric and Oceanic Circulation (x1)	The visual model minimally explains how patterns of atmospheric and oceanic circulation can impact hurricane formation and movements.	The visual model somewhat explains how patterns of atmospheric and oceanic circulation can impact hurricane formation and movements.	The visual model sufficiently explains how patterns of atmospheric and oceanic circulation can impact hurricane formation and movements.	The visual model thoroughly explains how patterns of atmospheric and oceanic circulation can impact hurricane formation and movements.
Latitude, Atmosphere,	The product provides minimal evidence of the role latitude,	The product provides some evidence of the role latitude,	The product provides adequate evidence of the role	The product provides strong

Achievement Levels	1	2	3	4
and Geographic Land Distribution (x1)	altitude, and geographic land distribution play in hurricane development and movement.	altitude, and geographic land distribution play in hurricane development and movement.	latitude, altitude, and geographic land distribution play in hurricane development and movement.	evidence of the role latitude, altitude, and geographic land distribution play in hurricane development and movement.
Phenomena that allow for Reliable Predictions (x1)	The visual model minimally explains critical phenomenon necessary for hurricane formation and movement and does not allow for reliable predictions to be made.	The visual model somewhat explains critical phenomenon necessary for hurricane formation and movement but does not allow for reliable predictions to be made.	The visual model adequately explains critical phenomenon necessary for hurricane formation and movement allowing for reliable predictions to be made.	The visual model thoroughly explains critical phenomenon necessary for hurricane formation and movement allowing for reliable predictions to be made.
Systems Thinking (x1)	The diagram presents minimal understanding of how parts of a whole interact with each other to produce overall outcomes in this complex system.	The diagram presents some examples of how parts of a whole interact with each other to produce overall outcomes in this complex system.	The diagram presents a reasonable analysis of how parts of a whole interact with each other to produce overall outcomes in this complex system.	The diagram presents a thorough analysis of how parts of a whole interact with each other to produce overall outcomes in this complex system.
Graphics and Visuals (x1)	The graphics and visuals provide little evidence to support the claims made through the visual model and make the information provided easy for the viewer to understand.	The graphics and visuals provide some evidence to support the claims made through the visual model and make the information provided easy for the viewer to understand.	The graphics and visuals provide satisfactory evidence to support the claims made through the visual model and make the information provided easy for the viewer to understand.	The graphics and visuals provide thorough evidence to support the claims made through the visual model and make the information provided easy for the viewer to understand.

5. Infographic

Your task is to create an easy to understand infographic explaining the value of information collected from weather satellites about potential hurricanes. Many people do not leave an area that may be hit by a hurricane because they do not believe the information from the media and government officials. The purpose of this infographic is to help reinforce the reliability of the data gathered from weather satellites and to help people understand how they function.

The purpose of this product for the non-profit is to encourage people to leave an area prior to a hurricane. This will help keep people safe and can help the non-profit prepare emergency shelters away from the areas of impact.

Within your infographic be sure to explain how weather satellites work including:

- The spacecraft.
- Potential orbits and what the orbit means for forecasting.
- Instruments, Sensors and Detectors used on most weather satellites.

Additionally, summarize the information that can be gathered through a weather satellite and how reliable that information is for forecasting hurricanes and other weather events.

- How can global forecasting be improved using satellites?
- How do weather satellites work?
- Why is the orbit of the satellite important?
- What are some of the important aspects of the Earth and Earthâ€™s atmosphere that can be measured by weather satellites?

Infographic

Achievement Levels	1	2	3	4

Achievement Levels	1	2	3	4
Graphical Representations (x1)	The graphics and visuals provide little evidence to support the claims made through the infographic.	The graphics and visuals provide some evidence to support the claims made through the infographic and make the information provided easier for the viewer to understand.	The graphics and visuals provide sufficient evidence to support the claims made through the infographic and make the information provided easy for the viewer to understand.	The graphics and visuals provide strong evidence to support the claims made through the infographic and make the information provided easy for the viewer to understand.
Systems Thinking (x1)	The diagram presents minimal understanding of how parts of a whole interact with each other to produce overall outcomes in this complex system.	The diagram presents some examples of how parts of a whole interact with each other to produce overall outcomes in this complex system.	The diagram presents a reasonable analysis of how parts of a whole interact with each other to produce overall outcomes in this complex system.	The diagram presents a thorough analysis of how parts of a whole interact with each other to produce overall outcomes in this complex system.
Research (x1)	The infographic provides few accurate facts and details providing the audience with limited information related to the topic and purpose.	The infographic provides some accurate facts and details providing the audience with pieces of information related to the topic and purpose.	The infographic provides many accurate facts and details providing the audience with important, accurate information related to the topic and purpose.	The infographic provides a large number of accurate facts and explicit details providing the audience with critical, accurate information related to the topic and purpose.
Movement of Atmospheric Oceanic Circulation (x1)	The infographic minimally explains how patterns of atmospheric and oceanic circulation can impact hurricane formation and movements.	The infographic model somewhat explains how patterns of atmospheric and oceanic circulation can impact hurricane formation and movements.	The infographic sufficiently explains how patterns of atmospheric and oceanic circulation can impact hurricane formation and movements.	The infographic thoroughly explains how patterns of atmospheric and oceanic circulation can impact hurricane formation and movements.
Satellite Innovations to Meet the Need to Forecast Hurricanes (x1)	The product provides a few examples of how a weather satellite can help forecast hurricanes to help keep people safe.	The product provides some examples of how a weather satellite can meet specific qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants based upon the need to forecast hurricanes to help keep people safe.	The product provides adequate analysis of how a weather satellite can meet specific qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants based upon the need to forecast hurricanes to help keep people safe.	The product provides thorough analysis of how a weather satellite can meet specific qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants based upon the need to forecast hurricanes to help keep people safe.

6. App Sketch

The non-profit has asked you to build an app that will help people prepare for hurricanes. Start by doing research on the steps people should take to prepare for a tropical storm.It may be helpful to explore other apps that already exist, for example Ready NC:

- https://readync.org/EN/Index.html

Create a sketch of your app and what will be included. Be sure to come up with a unique name, icon and a short description that will show up in the App Store. Include the sections of your app and the information that will appear in each section.

- What steps should people take before a hurricane hits?
- What sections will your app have?
- How can you make your app user-friendly for everyone?

App Sketch

Achievement Levels	1	2	3	4
Problem Solving & Design (x1)	Product is an attempt to solve the design problem by addressing audience needs and important factors mentioned in the description.	Product partially solves the design problem because it addresses audience needs and some important factors mentioned in the description.	Product adequately solves the design problem because it addresses audience needs and most of the important factors mentioned in the description.	Product thoroughly solves the design problem because it fully addresses audience needs and all important factors mentioned in the description.
Sketch Details (x1)	Sketch includes very few labels and details. The details are not very clear or easy to identify.	Sketch includes some labels and details that highlight features. The details are partially clear and easy to identify.	Sketch includes labels and details that highlight features. The details are mostly clear and easy to identify.	Sketch includes excellent use of labels and details that highlight features. The details are very clear and easy to identify.
Research & Accuracy (x1)	The product shows that students minimally examined complex ideas and information.	The product shows that students partially examined complex ideas and information in order to select and organize somewhat relevant content.	The product shows that students adequately examined complex ideas and information in order to select and organize relevant content.	The product shows that students thoroughly examined complex ideas and information in order to select and organize highly relevant content.
Engineering Criteria & Design (x1)	Product demonstrates minimal understanding of the criteria and constraints of the design problem with regard to the function of the product.	Product demonstrates some understanding of the criteria and constraints of the design problem with regard to the function of the product.	Product demonstrates adequate understanding of the criteria and constraints of the design problem with regard to the function of the product.	Product demonstrates strong understanding of the criteria and constraints of the design problem with regard to the function of the product.

7. App Programming Flowchart

The non-profit wants to create an app that highlights the steps for people to prepare for an approaching tropical storm or hurricane. Your team will need to create a programming flowchart in the form of a diagram that will be sent to a software engineer who will be developing the app. This flowchart can be created using software or with pencil and paper.

The flowchart should include a start point and an endpoint, decisions that need to take place along the way, the direction for the flow of logic, and processes. You will need to use symbols to represent the actions and decisions the users of your app will take. You may find it helpful to research a flowchart for an existing app as practice.

- What is a decision tree and how is it helpful when developing an application or website?
- Why is building a flowchart an important step before developing an application or website?

App Programming Flowchart

Achievement Levels	1	2	3	4
Decision Making (x1)	The flowchart is missing elements that should have been considered for selecting a final end-state. Poorly communicates the final end-state selection process.	The flowchart is missing elements that should have been considered for selecting a final end-state.	The flowchart somewhat effectively demonstrates important considerations and the process that contributes to selecting a final end-state.	The flowchart effectively demonstrates important considerations and the process that contributes to selecting a final end-state.
	The flowchart is cluttered	The flowchart has a usable layout, but may	The flowchart has an	The flowchart has an exceptionally attractive and usable layout. It is easy

Achievement Levels	1	2	3	4
Layout (x1)	looking or confusing. It is often difficult to locate important elements.	appear busy or boring. It is easy to locate most of the important elements.	attractive and usable layout. It is easy to locate all important elements.	to locate all important elements. White space, graphic elements and/or alignment are used effectively to organize material.
Logic (x1)	There is no logic to the flowchart. The flow chart has no order and is hard to understand.	The flowchart is present but there is a question as to which step goes in which order.	The flowchart is logical and the directions allow the reader to complete the task.	The flowchart is logical and the directions help the reader to (adequately) complete the task.
Spelling and Grammar (x1)	Several spelling or grammar errors	No more than 3 spelling or grammar errors.	No more than a couple of spelling or grammar errors.	No spelling or grammar errors